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SAFETY DEVICES AND PRODUCTION.

Paper presented to the Institution, Birmingham Section, 17th September, 1930, by E. A. R. Werner, O.B.E., B.A.

The President of the Birmingham Section, Mr. W. G. GROOCOCK, in introducing, as Chairman of the meeting, Lt.-Col. Pickard, General Secretary, Safety First Association, referred to the syllabus of lectures arranged for the session and expressed the hope that members would co-operate in making the meetings a success and adding to the strength and prestige of the Institution.

LT.-COL. PICKARD took the chair and read a letter from Mr. Werner regretting his inability to be present to read his Paper. They had secured an efficient deputy in Mr. Hepburn.

Mr. H. A. Hepburn, B.Sc., A.M.I.Mech.E., then read the following Paper, which was illustrated by numerous lantern slides.

"SAFETY DEVICES AND PRODUCTION."

IT is an axiom accepted by all progressive employers that the highest standard of efficiency and maximum output cannot be obtained except under the best conditions of employment. The conditions to which I propose to refer this evening may be grouped under three heads: Safety, Health, and Welfare. Each of these conditions has its bearings on production, both as regards the quantity and the quality of the output. Each of these prob-

lems, moreover, is well worthy of study by those interested in production, both as regards the physical and the psychological aspects. For example, if we can prevent an accident, apart from the humanitarian consideration of saving so much human suffering, we have the physical or practical advantage that production is not delayed by the temporary absence of a worker who has become skilled in a particular operation and the necessity of finding another worker (probably less expert at this particular job) who can be set on during the absence of the injured person.

Every one knows the psychological effect of a serious accident occurring in a room where numbers of other employees are at work. The production in such a room probably drops more than 50 per cent. at the time, and a long period generally elapses before the normal rate of production is restored. This is due to a number of perfectly obvious causes, which include definitely the tendency of a worker to slow up for fear it should be his turn next. Thus, I think it will be agreed that real safeguards which can ensure absence of accidents in dangerous operations ought to be matters of peculiar interest to the production engineer.

We are still occasionally met with the once general belief that "guards on machines hinder production," but I hardly think I need devote much time to disproving such a fallacy. An unsuitable guard may hamper production, but it is nowadays well within the ability of engineers to devise guards which will give the maximum of protection without in any way interfering with the rapid feeding of the machine. Innumerable instances have come to our notice of pieceworkers who have objected to a guard directly they have seen it, on the ground that it would slow them down; they have been persuaded into giving it a few weeks' trial, and thereafter the invariable remark is something like this: "I can work a lot faster now I have not got to be always thinking about my fingers." But to achieve such a result the guard must be efficient to the extent generally expressed as "fool-proof." Similar considerations can be applied to conditions which make for health in a factory, such as ventilation, warming, avoidance of dust, and the like: a healthy worker does good work and works fast. A factory where the sickness rate is high finds its production continually hampered by the absence of just the particular worker who is most needed for a rush job. Similarly with lighting: we can none of us get on with our work as we should like to do if the light falling on our work-table is either inadequate or unsuitable. Welfare conditions have a similar bearing on production. Bright surroundings stimulate output; suitable seats for work which can be done sitting reduce the fatigue which often leads to a fall in production towards the end of a day; and so on.

A year or two before the war the Home Office decided to erect a building in which, to show the best methods known to the Department for protecting industrial workers against accidents and for promoting conditions most favourable to health and efficiency. This building, known as the Home Office Industrial Museum, is situated in Horseferry Road, Westminster. The floor space available for exhibits is rather more than 15,000 square feet. The building itself, though of necessity primarily designed to serve the purpose of a museum, has been used as far as possible to illustrate, in its arrangement, matters such as ventilation, heating, lighting, fire escape, etc., which are of importance in the construction and equipment of factories. In the "Safety" sections of the museum, the exhibits consist chiefly of the actual machines, plants and appliances as they would be installed in a factory or elsewhere. Power is provided so that the machines exhibited can be shown in movement.

There are also in the museum exhibits of various machines illustrating the principles of safeguarding machinery, which I am classifying for this purpose under ten heads :—

(1) Incorporating safeguards into the design of the machine itself : Herbert's Turret Lathe, Town's Radial-Arm Drill, Old Radial-Arm Drill (contrast).

(2) Interlocking the dangerous parts of the machine with the driving mechanism : Carding Engine, Hydro-extractor.

(3) The provision of fixed or adjustable enclosing guards to the dangerous parts : Circular Saw, Abrasive Wheels.

(4) Provision of guards which automatically "sweep away" or remove the operator's hands from the danger zone : Power Press, Power Press (Udal's Guard), Platen Printing Machine (Udal's Guard), Platen Printing Machine (Udal's Guard).

(5) The use of instantaneous stop mechanisms which come into operation when the hand approaches the danger point : Laundry Calender, Corner Staying Machine.

(6) The provision of double hand controls so that both hands must be fully engaged while the dangerous parts of the machine are open : Garment Press.

(7) The use of reversing mechanism so that the motion of the machine will be reversed should the hand approach the danger point : Dough Brake.

(8) Automatic or remote feeding systems by which the work is fed into the machine without danger to the operator : Printing Machines.

(9) The use of mechanical appliances to replace hand operations : Belt Mounting by hand (dangerous method), Mechanical Belt Mounter (Saxon), Mechanical Belt Mounter (Broughton).

(10) Stopping the machinery for operations involving danger, *i.e.*, where other means for securing safety are not available : Clutch (Wigglesworth).

In the Health Sections the exhibits are necessarily of a different character. The important section devoted to the chief industrial diseases includes photographs showing the methods for the prevention of lead poisoning, silicosis, dermatitis, etc., in various industries ; charts indicating the incidence of the diseases in various industries over a period of years ; the "cautionary" notices issued by the Home Office for display in factories ; models illustrating the lesions, etc., produced by the diseases ; micro-photographs of lung sections, dust, etc. In the Anthrax Section also will be found an interesting exhibit of disinfected and undisinfected wools at various stages of the manufacturing process.

Two sections are devoted to illustrating the principles of efficient ventilation and lighting. The Ventilation Section includes complete installations (connected with the grinding and woodworking machinery exhibits) for the removal of dust ; demonstration installations of well-designed and badly-designed air ducts, and other ventilation arrangements ; photographs of actual installations from various industries. Arrangements for the protection of the workers against dust and fumes are also installed in the pottery, wool sorting and aerographing exhibits.

The Welfare Section includes rooms fitted up as (*a*) an ambulance room, (*b*) recovery room, (*c*) canteen, and (*d*) welfare supervisor's room. Here are also shown canteen equipment, types of work seats designed to prevent fatigue and facilitate efficient work, types of first-aid boxes for factory use ; many kinds of protective clothing, and photographs of welfare arrangements obtained from works covering a variety of industries.

The museum shows not only what is best, but, by contrast and by way of warning, dangerous plant and appliances which have been found in actual use, *e.g.*, in the electrical section apparatus which has been the cause of fatal accidents ; in the lifting gear section, ropes, chains, etc., dangerously worn ; in the steam plant section, parts from boilers which have exploded, showing the conditions which caused the explosion.

The development of safety, health and welfare in the factories in this country has been continuous and is still continuing. There is no finality about it and there can be no finality, therefore, in the exhibits shown in the museum.

The Home Office gratefully acknowledge the assistance which it has received in the establishment of the museum from many quarters ; from many manufacturers who have given or lent most of the exhibits ; and from other persons. It is hoped that the

interest which has already been shown in the museum will increase and extend, but the museum will need the continuous support and co-operation of industry if it is to render to industry the great service of which it is capable.

Discussion.

MR. WHITE said that in the early part of the Paper the lecturer mentioned the effect of the health of the worker on the efficiency of the shop. It would be interesting if he could state where figures could be obtained showing the effect in an ordinary engineering shop.

MR. W. G. GROOCOCK: The lecturer mentioned, in speaking of grinding, the necessity of having a flow of air from grinding wheels. I should like to know whether there is any definite regulation as to what that flow should be.

MR. EDWARDS: As to the psychological effect of accidents in factories, I think all of us will agree with the lecturer that they have a very harmful effect. We have, unfortunately, had accidents in our works, and the results were remarkable over a short period. I do not know if anything can be done to prevent this. The only thing that we do is to exercise rigid control over the people and try to prevent hysteria among the female employees I notice the lecturer showed quite a number of machines, but I did not see any safety device for milling machines. I know all production engineers feel that it is very difficult to get an efficient guard on a milling cutter which will not interfere with the output of the machine. With regard to safety guards on power presses, I have had some experience, and I can assure you that an efficient guard on power presses increases production. As the lecturer said, employees, after a short time, feel confidence in the guard, and they increase their speed of work. The guards we saw may be efficient, but I prefer a guard that has a side slide, because there is a danger of female operators fainting while they are at work, in which case they fall forward with the arm right through the press. Any press that takes hold of the arm cannot bring it far enough back to clear the tool. We have found in our works that by using an appliance on our power presses to blow away the work we have a real safety device. There is a tendency on the part of the worker to try to snatch articles that would otherwise fall into the tools. We are using compressed air with spring to pull work away as it falls from the machine.

Another point is the fatigue of the operatives. In inspection or viewing, the shape of the seat, the height and back rest, are very important factors, not only for the welfare of the person, but for the output. In inspection I use a 10in. magnifying glass, and have found an increased output of 30 per cent. in the inspection department.

It was very extraordinary to note that there were thirty thousand cases of people falling or tripping over objects in the factories, workshops, etc. I think it should be very strenuously laid down that all gangways in workshops and other places should be kept perfectly clear. There were only twenty-six thousand cases from moving machinery, so that the clearing of pathways for people to walk about is very much more important than guarding machinery, which we stress so much.

MR. YOUNGASH: I have to say that, with many others, I have sometimes disliked His Majesty's Factory Inspectors, not as individuals, but in their official capacity. I feel this evening that I have in the past very materially misjudged these gentlemen, and any misconception that may have been in my mind has been effectively removed by the present admirable lecture, and the assurance of the lecturer that the Home Office, and the representatives of the Home Office, are willing and anxious to help. My own personal experience with Factory Inspectors has always been of a nature that has not justified that particular feeling. They are always inclined to blame us, we feel, even when we have done our very best to prevent accidents that have happened. No doubt in course of time we shall get to understand one another better than we have done up to the moment.

I have had in the past the pleasure of acting as Safety Officer, with other duties, and it has caused me quite a lot of perturbation. I remember reading a book by Miss Prout on "Welfare Work," and if any of you can get hold of it, I advise you to read it. That welfare side of the Home Office activities is one that undoubtedly will rapidly develop. You must have healthy workers if you are going to get the best out of them.

The point I feel most concerned about to-night is, what is the Home Office doing to educate the worker? Their activities in the past have been mainly directed to guarding certain parts which prevent, and, where possible, preclude accidents, but we have, as marked to-day as at any time, the human element which, with some material saving of a small fraction of time, goes out of its way to circumvent guards and such like. I think there ought to be something done to educate workers to see the need, the importance, and the advisability of these guards from their own point of view. I hope the lecturer will tell us if there is anything being done in that direction.

I suppose it is extremely difficult to get any reliable facts as to the relative conditions over a period. Manufacturing operations are extending and an increasing number of people are engaged in industry, but I should very much like to have figures as to the results achieved by the various regulations that are put into force.

MR. TURNER: I wish to refer to the question of press tools, the side to side guard, the Udal, and the point that Mr. Edwards made about the Udal guard, that if a girl fainted and dropped on to the press, this pull-out guard would not take care of the arm. Our experience has been just to the contrary. We find that in the case of the side to side guard, unless set extremely carefully, the sliding action has been proved to be the cause of accidents, due to the plate on the side to side guard acting as a fulcrum and shoving the hand underneath the press itself. With the Udal guard, which we have adopted in place of the side to side, we find it will actually throw out the worker's arm if it goes into the operation, even if both arms are in, it will throw them right clear off it. Another important effect was this. When the operator was asked, "Now, are you afraid to work that machine?" he said, "No, not with that guard." It raised the morale of the operator one hundred per cent., and removed all fear.

Another point is as to belt methods, Broughton and others. One thing that occurs to me is the excessive cost to a firm to put these throughout the factory. We are adopting at the present time an inching device whereby we can put belts on by pressing a button and moving it round just a few inches at a time, in perfect safety and with less cost.

Mr. Edwards also raised the question of milling machine guards. That is a bone of contention to many. I have here photographs which I shall be glad to show to anyone interested, including His Majesty's Inspector, whom, by the way, we look on as a friend, and are never afraid to see him. This milling machine guard can be put out of position in a second (the previous guard might take you five or six minutes or more), and when you have a job at 2s. per hundred, and two off, you have no time to set your guard up. Another point which you have to take account of is that you can never, with the guards on the market at the present time, use your maximum diameter of cutter, which is taking off the efficiency, to which the lecturer has pointedly drawn our attention.

MR. HEPBURN: Mr. White asks about research on the health of the worker engaged in industry. I can only refer you to the publications of the Industrial Fatigue Research Board, which is a subsidiary of the Department of Scientific and Industrial Research. Research work is not only being carried out in all sorts of industrial problems from a mechanical point of view, but the results of the work are also being made the subject of a large number of studies.

With regard to the question about velocity of air in ducts. There is nothing laid down for it. Regulations require that dust must be effectively removed, but I think that if you figure on somewhere about seven thousand linear feet per minute in the main duct where it joins on to the hood, it will be sufficient to remove all the dust generated.

With regard to the psychological effect of an accident, I am afraid we cannot do much with that because so much depends upon the temperament of the workers in the shop. The only thing that can be done in a case of that kind is to have very strict and constant supervision over all people employed to see that they use guards and practise safety in everything they do. With regard to milling cutters. At the museum there is an extensive number of milling machines shown set up with guards suitable for different jobs.

The remarks on the fatigue due to eye strain are most interesting to me, because I think it is a point which ought to receive greater attention in factories than it does. A girl was examining articles to see if they were correct, and she had a plate of glass in a desk and underneath was an ordinary electric lamp shining brightly. She was suffering, clearly, from the work. A piece of ground glass and a daylight lamp underneath would probably obviate the difficulty.

Percentages of accidents due to machinery. I think roughly the number of machinery accidents only amounts to less than 20 per cent. out of the total reported to the Home Office. The other 80 per cent. were all due to causation apart from power-driven machinery, and it is to that 80 per cent. that our energies are being directed at the present moment. However, this means that on power-driven machinery we have only 20 per cent. to work upon. The other 80 per cent. I am afraid must be dealt with by you gentlemen yourselves in your works. I mentioned falling down and striking, and those others. The only way to get these down in your works is to stimulate the desire for self-protection in the mind of every worker in the place. You must get them to think that it is within their power to do something to help this, and I might answer part of another question here: "What are the Home Office doing to educate the worker?" The Home Office has no statutory powers to inaugurate any scheme of education of workpeople; I suppose there is enough work to do without that; and so that admirable organisation which our Chairman represents has come into being to help you to help yourselves in that respect. The National Safety First Association deals with all these problems which the Home Office cannot hope to deal with. But I do feel that you should support that Safety First Movement for all you are worth if you are concerned with the education of your workers, and the means are here to-day to help you to that end.

I am sorry I cannot give any figures as to percentages of accidents prevented by guards. As you know, the industrial population of the country is growing all the time, and figures for one year are hardly comparable with the figures for another year, and all we can do is to keep the figure as low as we can as we go along.

With regard to accidents due to particular types of press guard. I hope you will excuse me from entering into any discussion on the advantages or disadvantages of one guard or another. I have to be neutral in these matters, but I can say that a guard, to be efficient, should be arranged so that it strikes the hand between the wrist and the finger tips. If you have a guard which hits about the wrist you will find sooner or later you have an accident because of this fulcrum effect. Those of you who have got guards and do not feel quite satisfied with them, can always purchase or make an addition to the guard at right angles, or at an angle so that when the gate comes forward it hits the fingers. If you set it at that angle, you have a definite advantage from the angle of the guard, which gets the fingers instead of waiting until it gets the arm there. It all goes to prove that if you want your guards to prevent accidents, you must not put them on the machine and forget about them. You have got to treat them tenderly, for they are part of your production machines. They are helping in the efficiency of the worker, and if you look after the efficiency of the machine as well, and if you have no fear of the high speed, your production is secure. As to belt-mounting, I agree it is very expensive, but expense necessarily incurred will often save a great deal of trouble due to accident. The remarks on inching devices were very interesting. They are on show at the Industrial Museum, and when you are visiting there, you should make a point of asking the attendant to demonstrate to you how a belt can be put on with the inching device. They are useful and can be easily incorporated with the electrical system.

With regard to milling cutter, I shall be glad to see photographs, but at the same time I must warn you not to fall into the error of buying guards and saying "Now I have got a guard for my milling cutter. There it is, use it!" because there is no one guard that will serve all purposes. If you have got an extra large milling cutter you will have to design an extra large guard. Once you have a guard for a special kind of work, have it labelled. Just as you collect hundreds of dies, in time you will collect hundreds of guards, and there will be no excuse for not having suitable guards.

Mr. E. W. Field proposed a vote of thanks to the Author, to Mr. Hepburn and to Col. Pickard, and the meeting closed.

UP-TO-DATE MANAGEMENT.

Address given to the Institution, London Section, 1st October, 1930, by Herbert N. Casson.

MR. H. E. WEATHERLEY, President, London Section, was in the chair at the opening meeting of the Session and briefly introduced the lecturer, Mr. Herbert N. Casson.

IN the first place Mr. Casson warned his audience against the assumption that they knew everything that could be known about their own jobs, and, in order to open their brains—which were probably locked against all new ideas in connection with their own line of business—he told them quite frankly that, being young men, they all had a greater opinion of the extent of their own knowledge than they would have thirty years hence.

If he were asked to define "efficient Management" in two words, he would say that it was a character and a career. The time had arrived at which we should call management a career—a profession. Efficiency was the securing of the highest percentage of results by applying the scientific method to whatever one was doing. Efficiency was not system, as had been thought. One must have a system, of course, but it was only the A.B.C. of management. It meant only regularity, and not efficiency. For example, the regularising of stupidity did not make it intelligence. System could be exemplified by a ferry boat, which crossed a river regularly and always hitched up to the same post on either side, but a business firm was like a ship sailing on an uncharted sea, where the work of to-morrow might be different from the work of to-day, where one did not know what was going to happen next, so that everything must be ready for a quick job. Management was dynamic, and not static; it was based upon making changes. The manager stood above the routine, controlling it, guiding it and sometimes changing it, or smashing it to pieces if it were wrong.

Again, efficiency was not accountancy. There was no cure in accountancy; it merely gave a diagnosis, but never told one what to do. The bankers were getting more and more control; they did not know how to develop, however, but merely how to retrench. They only knew how to dig a funk-hole, but that was not efficiency. One never met a banker who advised a firm to double their advertising and increase the number of their salesmen.

Efficiency was not economy—pinching pennies, or slave driving, or Americanism. Incidentally, he mentioned that the first efficiency man was not an American; he was Charles Babbidge, a Professor at Cambridge eighty-five years ago, who had written a book dealing with scientific management, motion study and a mass of the other inter-related things we are studying to-day.

Efficiency was the application of scientific method to business, and its purpose was always to increase the net profits.

There were three wrong systems or forms of management—Muddling, Military and Bureaucratic. Muddling, of course, was not a system, and it was often found where a man was appointed to manage a business simply because the business belonged to his father. Management, however, did not run in the blood; cleverness was like lightning—it struck in any old place. Muddling management was amateurism, where no-one thought of his job as a profession or ever thought that he ought to learn it.

With regard to military management, he said that there were too many Sergeant-Majors. They had to boss somebody, for they had formed the habit of doing so, but they were of no use to business.

As an instance of Bureaucratic management he instanced the Post Office, which in its last financial year had made a profit of nine million poinds by refraining from re-instituting the penny post. Bureaucratic management was to be found in the Civil Service—which was neither civil nor service. Men with short salaries and long coats were engaged in tabulating the mistakes of yesterday, and there was no efficiency in it at all. Every large company tended to become bureaucratic, and every office manager was as much a bureaucrat as he dared. The railways were bureaucratic; he had not been allowed to make a report on the clerical work in the railway offices, where every little item had to be rewritten very many times. That system was not the right system of management.

The military and the bureaucratic methods were far more commonly applied than one imagined. He found the military system existing frequently in factories, where the works managers were driving their men, sometimes with curses. Slave labour was a failure, however, and it had ruined Greece, Rome, Egypt, Spain and the Southern States of America. To hand over a works to one's enemies could not be right. One man had boasted that he "raised hell" once a month. That man got what he had raised, however; he had had three strikes in five years.

Throughout his lecture Mr. Casson emphasised the importance of the proper treatment of the workmen. For instance, supervision in the sense in which it was usually referred to, could not be efficient unless one had a Scotland Yard detective behind every worker—and that was costly. What was really needed was self-supervision. If people were watched they would do the wrong thing immediately they were not watched, and they became experts at dodging the supervisor. For example, every new worker at a factory knew, on the morning of his arrival, just where to go for a quiet smoke and how long he could stay there without being caught. Military management led to blind, stupid, sullen obedience, which was of no use, and the management suffered by retaliation.

That point was well worth thinking over. Every worker had a right to his self-respect; that fact should have been included in the ten Commandments, but it was not yet realised. The ability to handle people was of very great importance, but technical people, because of their technical training, were usually not good at handling men. A chemist, for example, did not make a good manager, as a rule, because he was accustomed to handling material which had exact properties and always reacted in a certain way, and could not understand a man, who had no exact properties. When a man had technical knowledge he became superior and had a disagreeable manner. He was apt to place too much emphasis upon engineering technique; he wanted to be at his desk working out his ideas, and every man who had ideas was apt to be absent-minded, a little abstracted, superior, and rather bothered when anyone came to him, so that as a rule he was not popular with his men and was a bad manager.

As the result of his experience of the factories of England he had formulated ten rules for the handling of men, and they were rules which technical men very seldom thought of. They were as follows:—

(1) Make few promises—and keep them.

(2) Be fair. A manager should not have a favourite or a scape-goat; he was a referee, and his men were watching him to see that he was playing the game.

(3) Don't waste anger; use it. If a manager could not get mad about three times a year he could not hold his place, but, on the other hand, if he became angry every day people became accustomed to it and it was of no use. If he used all his language when a pane of glass was broken, he had no words left to use if something really serious happened.—(laughter). Anger was the last card to play, and therefore, a manager should keep it in his hand; it was valuable, and many times he had driven things through by getting into a blind fury.

(4) Always hear the other side in the case of a dispute.

(5) Do not hold spite. For example, if a manager had had to dress a man down on one occasion it was better to adopt a friendly attitude towards that man next morning than to ignore him; by ignoring him one immediately killed his loyalty.

(6) Never show discouragement. It was the duty of the men at the top to buck up the men under them, but there were too many sad-faced managers and foremen.

(7) Notice good work as well as bad. One should not blame a man unless one had also a word of praise for him.

(8) Watch for aptitudes; study the workpeople as a horse-trainer studies his horses.

(9) Give every man three chances. Every man had a right to make a mistake once; the first mistake was experience, and when it occurred it was well to explain to a man the reason it was made and how to avoid it in the future.

(10) Take your full share of the blame. This, said Mr. Casson, had never been done, but he always mentioned it.—(laughter). The practice of passing the blame through the factory from one man to another was silly, and if that practice could be eliminated it would be all to the good.

Another point to be borne in mind was that management meant a system of education, for a manager was a student and a teacher rather more than anything else. No foreman ever learned how to be a foreman before he occupied such a position, and he had to learn by experience. Unless management was keen, the task of the foreman was a very difficult one. Usually a foreman was blamed first for everything, and he had to have many excuses or he would not keep his job a month. If a man in his department was blamed for anything the foreman tried to transfer the blame to suppliers of materials or to a railway company which had been responsible for the transport; a foreman acquired his standing by transferring the blame from one of his men to somebody else. There was a technique for hiding facts, and that must be overcome by keen management. Again, foremen must be taught to co-operate and departmentalism must be promoted. A foreman had no right to step outside his own department, but, owing to lack of keen management, he had often to barter with the foundry and other departments in order that his own department could carry on. All that was irregular; there must be team play and company feeling.

With regard to organisation, he said there was the line organisation and the staff and line organisation—the latter being the right one. Line organisation meant authority. At the top there was the managing director, and immediately below him the works manager, sales manager, chief accountant, and so on, each of them being responsible directly to the managing director. Immediately below the works manager were the foremen, who were directly responsible to him, and each foreman had his own workmen, for whom he was responsible. Thus one had authority moving in a straight line downwards, the law being that no man could have two masters. If a worker had to report to two people he was demoralised; if a foreman had to report to a works manager and also to some infernal floating director he also became demoralised. The trouble with many firms was that they had "directoritis," for they hired dogs to bark and then did the barking themselves. Especially was this the case in family concerns. For instance, there might be four brothers, each one of whom must have a department—and God help such a place. They must hold a conference

before anything was done, and any one of the brothers could enter any department and give anyone an order. In this connection Mr. Casson recalled that he had been called in to organise the Custom House at New York. There were three men at the head, all of whom were political appointees, and all had equal power—one being appointed by the nation, one by the State and one by the city. He had walked out, however, for nobody could do anything there.

The staff and line organisation indicated the tendency in our industrialism to shift from authority to knowledge. In this organisation the managing director had full authority, as in the line organisation, but with him at the top there were specialists, such as the chief chemist, the advertising expert, perhaps an expert on lubrication, a lawyer, and so on, all of whom were above the managing director in knowledge, but they had no authority. They taught and advised the managing director and supplemented his brain. It was the new idea to have a living organisation with specialised parts, having no overlapping, no joint management, provision for under-studies, every man being in his right place, none being indispensable, the whole being formed like the human body, and run by specialists, all co-operating to achieve a set purpose. In his own company each of his employees was regarded as a specialist. For instance, the girls in his office were not referred to as typists ; one was called a filing specialist, another a circulation specialist, and so on ; that increased their self-respect and they worked better—and he had not to pay them any more.—(laughter).

An important point for a manager to bear in mind was that he should not do the detailed work himself, but should delegate it to others. In this connection he referred rather humorously to the tendency of a man when he was first appointed manager to contemplate with great affection the large establishment of which he had charge and to become so fond of it that he never wanted to be away from it. Mothers had been known to be so fond of their babies and to hold them so tightly that they smothered them, and for the same reason managers had been known to smother their businesses. He had seen many smothered businesses, and had had to tell a man to go away for a holiday and that when he returned he would find everything put right. There was a tendency for a manager to open his own letters and to spend two hours a day dictating replies of a most formal nature, the effect of which was to take the whole human touch out of the business and to drive customers away. Whenever a letter could be answered by anyone else that person should answer it. It was the duty of the manager to get away from routine ; he should know how to distribute responsibility to others so that he was left as free as possible for the real job of management. To manage properly one must pick the right man for the job, define that job, then leave him

alone and judge him by results. It was important not to nag a man. Let him make mistakes ; give him a chance. If he could not do so his job without the manager's help, what was the use of giving him the job ?

A manager, of course, must have at his command all the facts concerning his business, in order that he could control. For this reason he required daily reports. A statistical clock was of very great value, for it gathered up all the figures relating to the business and presented them in such a way that one could see at a glance how everything was going. Mr. Casson added that he believed Sir William Morris had one installed at his factory. The average managing director, however, lived in a fool's paradise, and did not know what was actually going on, for all he received was the favourable stuff.

It was often found that a manager did not know the actual working time of his machines. In this connection, Mr. Casson said that one of his test questions to the manager of a factory which he had to examine was as to the working time of the machines, and sometimes the manager could only reply that the factory had an eight-hour day. That was the reply he had received from the manager of a certain mill in which he had had to make investigations, but, inasmuch as the looms in that mill were making money only when the shuttles were working, he had timed the shuttle of one loom by means of a stop-watch and had found that it was actually moving for only one-eighth of the time, or, in other words, for only one hour in the course of an eight-hour day. Investigation showed that one reason for this was the breakage of the yarn, and the breakage was due to the ill-treatment of the yarn ; by taking steps to prevent the ill-treatment of the yarn the output of the looms was doubled at once.

Emphasising the necessity of making provision for the proper flow of the work, he urged that a manager must consider whether he had got 4-ft. gangways, whether the doors were in the proper places, whether there were bottle-necks or any other factors which tended to cause congestion. Almost every works he visited was only half finished. It was often the case that when a new machine was brought into a factory the manager would give instructions for it to be placed in a certain place just for the time being, but usually it stayed there for ever and was put into operation there, no regard having been paid to choosing its proper position so that the flow of output could be maintained. The mileage covered by the various components of manufactured articles in some factories was marvellous. We were beginning to appreciate the value of mechanical handling, however, and the fact that a job must be pulled through a works and not pushed through. The floor was not a shelf, and there should be nothing on it but feet, wheels and

machines. He had seen a pair of shoes made in thirteen minutes, but usually the average time taken to get a pair of shoes through the factory was two weeks.

Discussing the standardising of operations, he said that a consideration to which attention had been given only recently was that of teaching operators to carry out their operations so that their bodies were in the position in which their muscles were strongest. He did not pay so much attention to motion study as to teaching the workers the proper use of their own bodies, for there was not a worker in England who knew his own body. When a man was carrying out an operation at arm's length he was able to use only about five per cent. of his strength, and yet in many of our factories one saw operators working at very broad tables and carrying out operations at arm's length. His experiments had shown that the work ought to be brought to the work zone, which was about one foot from the body, at the waist level, so that the arms could hang and had not to be pushed out. One could hold an arm out straight for only about twenty minutes without becoming unbearably tired, but by proper attention to these matters in a factory, fatigue could be cured in five minutes. Another factor which retarded output was the bad tending of machines. It was the duty of the manager to find out the best way of placing machines and to see that they were properly tended.

Emphasising the necessity for the proper planning and preparation of work, he said that sometimes a job was started before it was ready, and the departments were delayed as a result. The sales, credit and buying departments, the drawing office, the tool and jig and the planning departments, all of which were preparatory departments, must finish their work before the foreman began. The foreman must never be expected to plan, beyond making his own local plan. In this connection he recalled that at one time he had been concerned with the making of aeroplanes for the Government. Each aeroplane comprised 127 parts, and as soon as sufficient parts for the making of three aeroplanes had been prepared the three aeroplanes were built very quickly. That was necessary, because Government Departments made changes every day, and orders were given that if any Government letters were received they should not be opened until a batch of aeroplanes had been completed; that was the only possible way of ensuring that any aeroplanes were built at all.—(laughter).

Above all, said Mr. Casson, one must humanise a works and try to eliminate class warfare. Whether or not class warfare existed in a works depended on the manner of those responsible for its management and their general attitude towards the workers. When visiting one factory he had found the managing director had not been inside it for three years; therefore, he had taken that managing director through, but had noted that he had been

scared to death of his own people—of whom he employed nearly 3,000. That was an instance of class warfare, and, of course, the factory never made any money. Again, one saw managing directors driving cars in and out of the gates of their factories when the workers were entering or leaving, hooting the workers out of the way. Why should a man want to plough his way through thousands of his workmen in a high-speed car, screeching at them as though they were dogs? He always put a stop to that nonsense in any place with which he had anything to do. Some people treated the workers in that way and then wondered why Bolshies came into the works and turned the place red. There was nothing Bolshie about people who were treated right. There was too much dignity and swank in our works, and it was fatal. A little of the human touch did a great deal, for employees were like soil—they must be fertilised. A number of young boys might be employed in a works, but nobody took the trouble to understand them, to find out what they were thinking about, how they spent their spare time or how they were getting on. Royce, the greatest engineer in England, had walked from door to door in Leeds for a job when eighteen years old, but nobody would engage him. Nobody had even looked at his face, which was one of the finest. Therefore, he had gone to Derby, and Leeds had been the loser. It was a valuable thing to get the rank and file to think. At Cadbury's works, for instance, 40,000 suggestions had been made by the rank and file, and every one was a good one—an indication that the workers there were thinking. There were three good wills in business—the banks' good will, the customers' good will and the workers' good will. A works was two-thirds human nature, and the problem was to get the full body power, brain power and heart power of everybody in it. One must give credit where it was due, and if a man had been with a firm for twenty-five years it was a good thing to give him a gold watch; loyalty began at the top. The endeavour should be to change the climate of the works so that there should be more June and less February, for happiness was a greater power than steam—though technical men could not understand that. First one must get the heart power of the men, and the body power and head power would come afterwards.

Discussion.

Mr. Gordon England opened the discussion. After thanking Mr. Casson for his inspirational address, he said the real theme of the address had been the importance of fundamentals, and in principle Mr. Casson was right. Emphasising the points which had impressed him most—for he was not at variance with Mr. Casson's views, and therefore, could not criticise the address; Mr. Gordon England said that the first point was the importance

of keeping an open mind. It was very difficult to do that, and he often found himself resisting the open mind, but when he did realise the importance of it and became humble he was always sorry for the attitude he had taken. That was one of the biggest difficulties the technical man had to face ; there was nothing more dangerous than technique, because once it had been produced it became crystallised, and anything that was crystallised was static. Technical men did not realise that the true technique was a flow process, just as was production.

The second point that had impressed him was that management was a career—another fact which was not appreciated in its full significance. Thirdly, management entailed flexibility towards change, and he appreciated that thought immensely. The fourth point—and it was the centre piece of the whole address—was that management was intelligence and right thinking. On the previous day he had been in conversation with a specialist in management problems, and both had concluded that modern words such as "rationalisation," "simplification" and so on, were all wrong, inasmuch as they were merely catchwords and were apt to crystallise themselves and become a dogma instead of a living thing.

Technical people had much to learn in regard to the dominance of the human element in all management problems, and he recalled that, in a paper he had read, dealing with the conservation of human energy in industry, his theme had been the importance of the human element. Our wonderful factories served only one purpose in the ultimate, and that was the human factor ; remove human desires and intelligence from any operation, any service, or anything at all, and the thing had no value—there was no such thing as intrinsic value.

With regard to retaliation, Mr. Gordon England spoke somewhat feelingly, and said that all who were concerned with management knew something about that, particularly those who were dealing with trade unions. They were retaliating for what our forerunners had done, and that was perhaps the finest lesson as showing how potent a weapon retaliation could be. Perhaps Mr. Casson was right when he had challenged technical men as to their inability to handle men. If a manager were not absolutely flexible, he could not handle the only flexible thing there was, i.e., the human mind. There was no reason, however, why technical men should not adjust themselves. The statement that managers were students and teachers was one of the truest things that could be said ; one of the keys to successful management was the realisation that one was a student and a teacher. A manager was just a "position" in the flow of thought production, and was just passing on knowledge.

The staff and line theory was extremely interesting; it was so simple, clear and logical that he had never thought of management

in that way. With regard to the delegation of responsibility to others, he recalled that quite recently it had been suggested to him that he might try to " work himself out of a job," i.e., to delegate a duty to someone else, and he considered that was a very wise policy.

Emphasising the necessity for a manager to be in possession of all the facts concerning his business, through a statistical department or statistical clock, he admitted that the mistakes that he himself had made had been due to lack of knowledge of facts. Finally, he commented on the fact that Mr. Casson had dealt with the mechanics of production only at the end of his lecture, and had dealt with the fundamentals first. It appeared, therefore, that in Mr. Casson's view the mechanics of production was the least important matter, whereas the production engineer was very much inclined to regard it as the beginning of the story. One's conclusion was that if they applied to their difficulties the fundamentals Mr. Casson had mentioned they would not be let down.

MR. CASSON, commenting on Mr. Gordon England's remarks, and particularly with regard to the human element, said that when one went into a works with a stop-watch and tried to study a man's work the Secretary of the appropriate trade union was called in and all sorts of trouble arose. One might decide to go round a works to ensure that the belts were being preserved—and six belt breakages out of seven could be prevented—but as soon as one began to make improvements there was opposition and trouble, unless, of course, the hearts of the workers had been won. Given good will and good feeling, forty per cent. of the problems would be solved by the workers ; one could not get more efficiency than the workers would give. There seemed to be a general misunderstanding about fundamentals. They were not things which had to be taught at Oxford or Cambridge, but by technical men they were usually placed on the same plane as an Oxford accent. He was told that he was always telling people the obvious, and that was perfectly true ; he had sold many pounds-worth of the obvious, because the obvious was the thing that everybody ought to know, but did not know, because they never thought about the things they saw every day. Radical improvements had been made in every business and every side of civilisation from outside. For example, Pasteur was not a doctor, but he had changed all medical science ; Ingersoll was not a watchmaker ; Eastman, who made the Kodak, was a bank clerk ; and so on. Every man had to consider how to prevent his technique becoming frozen, how to be a skilled specialist and yet go on learning. His own rule for that was never to let a day go by without doing something creative, no matter how small that might be. The way to learn, and to avoid becoming static, was to create, because one had to learn in order to create.

MR. GERARD SMITH said that probably all of those present would have liked their Boards of Directors to have heard the lecture. Discussing Mr. Casson's comments on the Civil Service and the railways, he said his own experience was that in those organisations, as elsewhere, there were the good, the bad, and the indifferent; there were, however, some very bright spots indeed, though in some cases the methods were atrocious. In organisations where there was much inefficiency it was often due to the fact that a manager tried to support the whole thing and to keep everything in his own hands. He disagreed with Mr. Casson's views as to office managers, and suggested that the trouble in industry was not the office manager but the accountant, because the latter was rather hard boiled and would not move. A firm which had the sense to appoint as office manager a man who was not an accountant, but a man with an open mind, ready to make changes as required, was usually efficient. Another trouble in the majority of offices and business was that if a man was not loaded up to the brim with departmental responsibility, it was considered that he was not earning his money. Therefore a man had not time to think about anything beyond what he was actually doing. The result was that when an outsider came in, unless he was a man who could get hold of one of the directors, he could not find anybody who had the time to think out what he had to offer. As an instance of the difficulties that arose through failure to prepare a job, he mentioned one instance in which a finishing department had received an order direct from a customer. This department had not sufficient material for the job in its own store, and had had to go to other departments, so that the various departments were ordering from each other. In addition, some of the material was not stocked at all, and had to be made specially. He had insisted in that case that there should be central planning, and that the finishing department should never see an order until everything was ready for that department to start work. Finally, discussing the human element, he recalled that during the war he was engaged in Messrs. Hans Renold's fuse department, where nearly fifty per cent. of the staff had been cotton operatives previously. On one occasion, when standing outside the works, one of the workers had asked who a certain "old bounder" was and, when told that it was Mr. Hans Renold, had been greatly surprised, because Mr. Hans Renold had been interested enough to ask him how he was getting on, where he lived, and so on. That, said Mr. Smith, was one of the great secrets of success.

MR. CASSON, in the course of his reply to Mr. Smith, said that mechanical accountancy was being applied in Germany very widely, as the result of which the banks now employ only about two-thirds the number of clerks they employed previously. A new kind of accountancy was coming in, and bound books were being replaced by loose-leaf ledgers and cards. We, in this country, however, were

only just dabbling in mechanical accountancy so far. In one office he had visited he had found twenty-seven sales ledgers in a heap outside the safe, and as the result of his investigations he had been able to get rid of all but three of them. The reason they had been used was that some slick salesman had sold the books to the firm in question. So far the equipment of an office had depended to a large extent on the cleverness of the men who sold machines, and machines were installed without regard to whether they fitted the work of an office or not. The problem of office equipment was being studied with a view to finding out which machines were best suited to certain work, how big an office should be before mechanical appliances were installed, and so on. One of the troubles in many offices was congestion due to too much copying, the accumulation of unnecessary materials in files, etc.

Mr. F. A. Perkins asked how an up-to-date manager should deal with a situation in which, after having secured team-work, loyalty, enthusiasm and the good-will of the workers, and having increased output thereby, it became necessary, by reason of a trade slump, to dismiss some of those men, leaving those who remained to wonder whether they had been wise in co-operating to increase output, and whether their own interests would not have been better served if they had refrained from so doing.

Mr. Casson said there was no satisfactory answer to that question. One could only say that if a manager was able to win the good-will of his men so that he had no labour troubles, and so that he could reduce the labour costs per article, the overhead charges and the cost of supervision, and eliminate waste, and so that his firm could sell a better product at a lower price, that firm was less likely to experience a slump than it would be otherwise. Not every firm, of course, was feeling the depression to-day. It was a pity, however, that sometimes, although an efficiency manager was able to increase output and decrease the cost of production and the selling price, his firm had a bad sales manager—perhaps a man who was occupying that position simply because he was a nephew or a son-in-law of the head of the firm. Again, failure might result from bad finance ; it might be due to the borrowing of money on the short-term basis (six months loans) and the selling of goods on the instalment plan, giving three years' credit.

Mr. Perkins said that many engineering products were bought by Governments, but every Government in the world had overspent and was cutting down its purchasing, and very often the things the engineer made cost only a very small proportion of the total cost of the work for which they were used. No amount of salesmanship could force a Government into buying in those circumstances.

MR. CASSON agreed that the demand for a product might decline through causes which were beyond the control of the manufacturers, and nothing could be done to keep the factory in operation unless some other product was made in the place of the old one.

MR. F. L. SHARPE recalled a point made by Mr. Casson some ten years ago, in the course of a lecture, to the effect that one's outlook was broadened considerably by small changes of routine as, for instance, by such simple changes as travelling to the office occasionally by a route other than that usually followed. Mr. Sharpe also emphasised the value of boys' clubs as a means of giving a boy a sense of his responsibility as he grew up. In his own town a good deal of success had been achieved by forming such a club, which was non-political and was attached to no religious order. The committee included the local school masters, a good representation of business men and the local inspector of police. The club was attended mostly by the poorer boys, who could not get enjoyment at home; they paid a penny per week. The rougher element had to be taught to respect their employers. By the time they had got into business they had already learned to appreciate the business men on the committee, and usually they turned out to be honest, genuine and respectable workpeople. A boys' club was well worth taking an interest in, because if a boy was cared for early, he usually turned out to be a good worker and good citizen.

MR. CASSON agreed that boys' clubs were of very great value.

MR. V. GARTSIDE asked for Mr. Casson's opinion of the management of engineering shops generally in this country—apart from the mass production shops, which were wonderfully well managed. He agreed that there was a tendency for technical men who were concerned with management to become too wrapped up in the technical part of the business so that they failed to give proper attention to the actual management. Further, Mr. Gartside asked what was the position of the real manager, and what he was supposed to do; i.e., in a works having its managing director, board of directors, works manager and other managers, which was *the* manager. If that was made clear, he said, many difficulties would be settled. Finally, he asked whether a manager should know all the details concerning his business or whether he should leave them to other people. If a manager did not know anything about the things that were being made, could he possibly manage the business as it should be managed?

MR. CASSON replied that a manager should learn everything he could possibly learn about the business he was managing but, having learned it, should delegate the routine work to others. He warned managers against trying to be busy—their job was not to work, but to think. The manager of a works was in much the same position as the captain of a ship—when things were going right he should have little to do. For instance, the captain of a ship would not

go down to the cook's galley and make omelettes under ordinary circumstances—it might be a good thing if the captain knew how to make omelettes, in case the cook went overboard, but he would not make them ordinarily. Mr. Casson also recalled that the general manager of a large American undertaking, employing forty-five thousand men, was frequently found in his office with his feet on the table and with a cigar in his mouth, because the business was so well managed that he had nothing to do. The greatest folly of which a manager could be guilty was to become frantic over trifles.

Mr. C. E. Mackellar suggested that there was no better training for managership than that of a subaltern in the army, because from the beginning of his army career the subaltern was taught to study his men, to find out their inclinations, their habits, their peculiar idiosyncracies, and to take a keen interest in them. Then, as he achieved higher rank it became natural for him to study his men and to adopt a sympathetic outlook towards them.

Mr. Casson replied that whenever he had to engage managers or salesmen, and found that an applicant had been in the army for ten years, he declined to engage such a man. The fact that a man had served in the army during the war period only did not influence him in that way, because such men were really civilians and became soldiers as little as possible. The professional soldier, on the other hand, developed a type of mind which made it very difficult for him to understand what business was. He himself knew ex-army officers who were trying to get into business, but they could not do anything ; they had no initiative and had become automata. The army took away initiative and brought in blind obedience—it destroyed personality. Therefore, militarism should be kept out of business. He had heard from many who had served in the army that they did not approve of the system of abolishing initiative and destroying personality among the rank and file and the lower grades of officers.

Mr. R. J. Mitchell (Member of Council), in a tribute to Mr. Casson for his lecture, said he had never heard so much concentrated truth expressed in so short a time, and suggested that if the essentials in Mr. Casson's remarks could be circulated in the form of a letter every morning for a year the effect nationally would be dynamic. Dealing with the economic situation, he said he considered that engineers as a body were running away from the problem of unemployment and depression like a lot of cowards. It was a disgrace to the engineering profession, to all the institutions, including the Institution of Production Engineers, to all the Chambers of Commerce, to Parliament—though nothing that he could say could add anything to one's contempt for such a body of men as were in Parliament—a disgrace, in fact, to all the so-called intelligent and organising heads of the nation, to lie down and say that the present condition of affairs was the will of God. Everybody still

required just as much to eat as did the people of twenty years ago. There are now more people in the world than there were twenty years ago, goods and services had become incalculably more diversified, and on every hand there was competition to try to make a man spend out of his savings more than he could really afford. Since the war there had arisen a new competition for the money of the middle classes, using the term in the economic sense; there were motor cars, wireless sets (soon there would be television sets), washing machines, vacuum cleaners and other electrical equipment in the house, and soon aeroplanes would be taking their share in the appeal. That being the case, the purchasing power of incomes, if anything, tended to go down, the total amount of incomes sometimes went down, but the total productivity of all the machinery created became greater, and the warehouses of the world were bulging with manufactured products, whilst the provision of food for the world had proved to be child's play. Nobody had talked about instituting a rational means of distribution, however. Brains of the kind that could create a five-valve wireless set, a Roll-Royce engine, the Scotch express, the "Lusitania" and many other big jobs could, if they chose to become organised, find a solution to this problem of discovering what sort of stores ticket—money perhaps—should be inaugurated to coax these goods out of the factories into the hands of those who wished to use them. That was the biggest problem confronting the engineer to-day. All that was lacking was the whole-hearted determination on the part of engineers that they would not be bamboozled by international moneylenders. Machinery was the greatest blessing ever introduced on this planet, and the proper use of it could ensure the building up of civilisation to pinnacles which the mind of man had never dreamed of up to the present.

Mr. Casson said it was clear to him that Mr. Mitchell would have liked to have developed his theme towards the institution of a new kind of currency. What was wanted, he said, was a condition of steadily rising prices, because when prices were rising we could buy and plan ahead, whereas when prices were falling we bought only from hand to mouth. In this country we needed to increase our business by only eighteen per cent. in order to employ all those at present unemployed and, as showing that that was not impossible, he said he knew many firms who had increased their business by more than that amount last year. There are employed in this country 700,000 more people than were employed five years ago, but we were being beaten by the birth rate.

At the conclusion of the discussion a hearty vote of thanks was accorded Mr. Casson for his address.

WORKS COSTING AND ITS RELATION TO PRODUCTION.

Paper presented to the Institution, Coventry Section, 1st October, 1930, by A. G. Rose.

IN approaching a subject of this nature it is well to have at the outset a clear idea of the extent of the subject, and to get an understanding of just what we want to know. Briefly, we want to know what works costing means, what part it plays in the control of a modern production unit, how this has come about and whether this practice is sound. Let us consider first the broad principles which govern the administration of a modern manufacturing business, and whittle the subject down until we have confined the issue to the activities of the production and costing departments. This brief reference to the complete operation should prove of value to most of us, since the key-note of this paper is as much a lament for the imperfect understanding on the part of technical men generally of the function of management, and the use of figures in particular, and it is an outline of the efficient control that modern business demands.

The first concern of present day administration is its duty to its shareholders, which can be crystallised as "Return on Investment." The chief avenues by which this is controlled would probably be stated in this order: (*a*) Sales volume; (*b*) control of inventory or stock investment, and (*c*) factory costs, but it is for the Board to frame the policy to achieve this end.

Sales volume is, of course, the chief concern of the sales department and the production schedule or programme with which we are familiar is the management's interpretation of the available business. The two remaining items are the means whereby investment is kept at an efficient minimum. Each is of tremendous importance to both cost accountants and production engineers, and it is the necessity for these controls, how they are established and how they are used that we particularly want to examine. The fact that these two items have become so large a part of management proves their soundness and this means, of course, that they represent our present conception of absolute efficiency.

Production is the primary function of any manufacturing concern, and the function of cost accounting, which is simply the domestic part of the counting house, must necessarily have its first interest in the main plank of the business. The relation of cost accounting to production is therefore a very intimate one.

The influence of cost accounting on modern industry is such that it is now generally accepted as the " pulse of business "—the means whereby the administration knows exactly its position from day to day. Its influence is felt in every phase of the business, and the management in consequence is armed with those vital facts, which, as the forerunners of quick decisions, make just the difference between profit and loss. Modern cost accounting practice has become an indispensable part of business control. This then is what works costing has come to mean, and is the part it plays in control. Let us now reflect just how this state of affairs has been brought about, and see just where we have failed and are still failing.

Costs were originally compiled for the purpose of setting selling prices, and it was a long while before any method of costing was conceived, which was capable of materially assisting the operating department in its daily work. Probably the first attempt scientifically to control any phase of production costs was the introduction of the measuring stick provided by piecework, and its success has been such that its application in some form or other has now become universal. Until recently, however, very little progress had been made towards controlling the remaining elements of cost. This was due in no small measure to the secrecy with which the old business school has invariably surrounded the details of overhead expense. They were usually kept under lock and key and available only to the senior executives. This in turn has created the water tight departments that we still find to-day, where we find the interests of the production and finance departments practically divorced from each other, and each jealously guarding from the other what they fondly imagine to be important secrets. It also largely explains the profound mystery which the average production man associates with the financial operation. Production has always taken pride of place in the affairs of the Board, necessarily so, of course, and when we remember that many members of the management have graduated from this school of thought we begin to understand why figures have not hitherto taken their proper place in the matter of control because these excellent gentlemen were not usually strong in financial organisation.

Our works accounts systems have for the most part, largely as the result of this attitude, been of patch-work building, and have as a consequence seldom had any value other than historical, generally very ancient history, too. Too often then the result is what we see to-day—water-tight departments and records of history only. This probably explains why the more extensive use of figures should have found us wanting, in that the training handed down to us has not provided many opportunities outside the immediate scope of our own department, neither has it displayed much encouragement towards the acquisition of such learning. It has

made us bad starters towards our first objective—good team work—and this something which is missing from our application to modern methods is perhaps best summed up in the word co-operation. Perhaps it is that we, as a business nation, do not really understand just what the word means. Anyway, generally speaking, it is certain that we are a collection of departments, invariably self-sufficient, often very efficient, but seldom working smoothly as a united whole. If I were asked to place the responsibility for the continued existence of these conditions, I should certainly say that production engineers are among the worst offenders. Within their own department they are certainly efficient, and are often very brilliant technicians but, when it comes to figures, they are generally the most pathetic boneheads.

Modern business doesn't want that attitude—it calls for a mutual understanding, complete confidence, absolute co-operation, and the ability to read figures and to understand their trends. Obviously to do this, these figures must be made available to the production man so that he can exercise full executive control, but equally obvious is the fact that the production man must show his willingness to take the wider view and to co-operate for the common good. He must learn how to read figures compiled for his use, and to appreciate the conclusions to be drawn therefrom. He should welcome the suggestions of the cost man in this connection, and not be above seeking his assistance to formulate the necessary action. As budding executives, the wisdom of this attitude should appeal to most of us. Figures are valueless unless used to the full, and the cost man's job finishes when he has displayed the result of your operations in figures with perhaps a brief report. But it is for you, the production man, to interpret and use them intelligently.

Now, the first relationship between the two departments is the personal one, and this is not nearly so good as it might be. The exact reason for this is difficult to define, but it is a state of mind which as we have already said, probably owes its origin to the conservative methods adopted by the pioneers. This may have been necessary and was probably sufficient for their purpose but, in the same way as competition is gradually eliminating the comparatively small business, so are the small business methods being superseded by the wider outlook of the junior executive who controls only a part of the complete organisation.

As we have seen, this is due more to their training than to any lack of real appreciation but, since figure control has come to stay, it is certainly up to us to meet this first requisite squarely by breaking away from this imperfect understanding and going all out for co-operation. We cannot over-estimate its value, and when that is an accomplished fact the production man will find that the cost man is really his best pal.

We will now examine a typical modern system of figure control, and see how the interests of these two departments are interlocked. We shall see how it simplifies the job of getting the work through, but this by no means infers that the production engineer of to-day will eventually become the machine minder that we knew as the skilled turner of yesterday. Production engineers will always be in evidence, and figure work is simply a means to efficiency.

Factory Costs.

Generally speaking, costs are not compiled as the basis for selling prices. Selling price is usually determined by such factors as competition or economic conditions, but obviously if a company is to live, factory cost has got to be something less than selling price, and that something has got to be sufficient to satisfy the "Return on Investment" required. Factory cost must not only state the overall and unit cost of production, but must indicate just which lines are earning profits or making losses, and must constantly point to where savings can be effected. It is not sufficient to know that the cost this month is so much more or less than the cost for the preceding period. The figures must emphatically answer the inevitable *why?* But unfortunately they very seldom can, since the unit cost resulting from the simple division of units produced into the total cost does not usually provide the reason, neither does it convey the information that the executive really wants. Many of our periodic costs may vary by only a fraction of a penny, which is usually considered satisfactory and not requiring explanation, but this attitude towards figures does not get us very near the real truth, and is certainly not in the interests of efficiency. There are few businesses that will not respond to a closer figure control because we shall probably never reach the point of hundred per cent. efficiency. Our aim should be to get as near to it as possible, however, and the following system contemplates the prompt compilation of figures in a form which is simple and readily understood by all who have to read them. In other words, it is designed largely to help the production engineer in his daily work by viewing the factory in much the same light as we regard an automatic machine where, with fixed speeds and feeds, unknown quantities are not very much in evidence. This system, which so readily lends itself to figure control, is called a system of "standards" which has elsewhere been termed a scientific control in contradiction to the military system of direct supervision.

Standards were applied in the first instance to "mass" production or at least "batch" production concerns, but some modified form of standards can be successfully applied to almost any manufacturing concerns. By "standards" we mean the measuring of expenditure against predetermined units, and probably the standard with which everyone is now familiar is piecework where, for any given operation, a fixed price is paid. The system permits of

an easy segregation of the known quantities from the unknown quantities, and the display of the fluctuating elements for constant scrutiny as a means towards keeping these at a minimum and establishing a constant unit cost. This constant cost is, of course, an operating or control figure, since as we shall see, actual cost will never be exactly absorbed by the standard cost.

By factory cost we mean all that expenditure necessary to manufacture and deliver our product at the factory gates expressed in terms of per unit produced. This expenditure is for the sake of convenience classified into material, labour and burden, but before we consider each of the elements individually the first point we have to decide is just what is to be the unit to be costed, and the obvious course is to take the unit we have to sell. For instance, a car manufacturer doesn't sell the grinding operation only on a cylinder block, but the completely machined block, or it may be the sales unit is a cylinder block assembly, i.e., the machined block plus other machined parts assembled thereto. To cost each of the individual operations involved in this assembly would mean a sheer waste of time, and would not convey any information of worth.

Having determined the unit we will take the elements.

Material.

This is some times known as direct material and is all that material which appears in tangible form in the accepted finished product. I emphasise the word " accepted " because such unknown quantities as scrap must definitely be excluded from this classification. This is costed from a specification prepared by the drawing office, and is not priced upon stores issues. We need not concern ourselves seriously with the control of the material element, however, because apart from such modifications as may suggest themselves from the planning standpoint, the production man can do little to influence this item of cost. We can, however, say with certainty that subject to the rise and fall in the price of raw materials, which can be catered for, under the heading of " burden " the material cost of a hundred units produced within the accounting period will be exactly a hundred times the cost of one unit, i.e., the material cost of a hundred good cylinder block assemblies will be exactly a hundred times the cost of one good cylinder block assembly. A certain amount of material will probably have been damaged or destroyed in the process of manufacturing a hundred good units, probably twenty or thirty, but this loss or scrap is not considered part of the material cost, but is reckoned under the heading of " burden." Direct material then is the tangible material shown in the finished job, and can therefore be controlled a hundred per cent. With this element of cost fixed then, and outside our control, we, as the production department, simply look to the stores or material control department to see that the material called for by the schedule is made available for our purpose at the specified time.

Labour.

The second element of our cost, i.e., direct labour will also reflect this constant ratio of one to hundred since the standard in this case is the piece rate or time study, whether applied to one individual or to a group of individuals. This is the standard which is most commonly known, and a little reflection of its principles will perhaps give us a better appreciation of its general application. The qualification to this remark of constancy is, of course, that labour cost will remain constant only provided we exclude inefficiencies, i.e., the difference between earnings and guaranteed basis rates when earnings are the smaller, and any abnormal allowance that may be made. These are readily calculated and are charged to an account within the burden classification, where they speak very much more forcibly than they would if their identity were lost in the overall figure of productive labour. Incidentally, the production man is in a much stronger position with his subordinates with the *why* that will eventually be put to him.

Cost men generally are not absolutely agreed on what is direct labour and what is indirect labour but, generally speaking, any repetition job which can be measured against a predetermined time or price is usually considered as " direct labour." Whatever system of payment is employed then direct labour is capable of being controlled a hundred per cent., but here again, unless the production man controls the activities of the time study or rate fixing department, he can, apart from the suggested re-routing of a given operation, do little to influence the cost.

He can, however, once the labour standards have been established, readily estimate the direct labour force he requires to meet his production schedule, and it is up to him to see that every facility is given the operatives to earn the maximum possible and, as soon as the flow of works stops, to see that the operators are either sent home or " clocked on " to day work.

Burden.

The remaining element of our factory cost, burden, or overhead offers the production man the greatest scope for control. This element includes all the remaining expenditure, i.e., indirect labour, consumable materials, fixed charges, etc. All the unknown quantities of day to day business are embraced within this category but, before it can be absorbed into the unit cost, we must first collect together the total amount of this actual expense.

Our manufacturing expense will be tabulated by symbols, or under a full classification showing, say—

Indirect labour (managers and assistant managers, foremen and assistant foremen).

Consumable supplies (cutting compounds, shop supplies, stationery).

Tools (replacements).
Power, light, heat and water.
Maintenance.
Losses, etc. (scrap, guarantee).
Fixed charges.
Miscellaneous.

And this is where the modern accounting machinery is called in to collect the mass of documents to be summarised.

Having collected our actual expense in this way we are faced with the three-fold problem of—

(*a*) How this expense can be absorbed into the unit cost,
(*b*) How the standards for overhead are to be established,
and (*c*) How the efficiency of the factory responsible for this expense is to be measured.

Burden is usually absorbed into factory costs, either as a percentage on productive labour or as so much per productive hour (either hand or machine). We will follow the former, as being the simpler to demonstrate.

" Capacity."

First the total expense at a given volume of productive labour must be ascertained. The point at which this is usually established is known as " capacity." The question of " capacity " is rather complex and technical, but suffice it to say that it represents the output at the bottle neck of the plant during a normal working week of say forty-seven hours. We can measure the volume at this point and from our time studies express this in terms of productive labour sterling. Now we must ask the question " What is the total expense we are prepared to stand against each of the account headings whilst working at capacity ? " In other words, what is to be the normal expense at normal volume ? By means of a careful estimate based on recorded experience and intelligent forecasting, we can establish the total expense to be expected at this volume. The percentage of this expense to productive labour will give us the percentage to apply to our unit costs for the purposes of recovery and theoretically this will absorb the expense exactly. In actual practice this never occurs, of course, but it works out remarkably closely.

It may be remarked that an overall percentage would not reflect the condition of true costs that this ideal sets out to achieve, since the expense of one department per £ of production labour may be totally disproportionate to the expense of another, or that the loss from scrap on one part number may by reason of delicate material or intricate workmanship be grossly excessive in comparison with another part number. Since it is intended that our standards shall reflect true costs, it may be necessary to break down the figures of expense departmentally in order to get the

correct burden application. A highly mechanised department for example would infer a low direct labour cost and heavy depreciation charges, and it would obviously be unfair to short load the products of this department with an overall burden rate common also to the products of a sister department employing hand labour extensively.

Known and Unknown Expense.

The second part of our problem is to establish the standards by which the efficiency is to be measured. We have already established our " normal " expense at normal volume, now the next step is to establish the expense at the other end of the scale, i.e., idle plant point or that expense which we shall expect to incur when the plant is standing idle and when production is nil. To do this we shall have to consider each account within the classification, in fact, we must take it even further than that and consider each item included in each account, and ask of each one " Would this expense be incurred in the event of a shut down ? " so that we can determine which accounts or what part of each account is fixed or non-variable in amount at any point of production between " zero " and " capacity " and what amount of expense can be considered as variable in direct ratio to volume. A little thought here will soon make it apparent that the total expense of a business does not vary in direct ratio with volume. If it did, everything would be plain sailing but, since it doesn't we must go to the extent of analysing it into the two categories of known and unknown.

Fixed Charges.

The first item under the heading of known quantities is fixed charges, under which is included such items as rent, rates, depreciation and most insurances. The nature of these charges precludes any possibility of control, since they are not affected by production volume and, as their name indicates, they are comparatively speaking fixed in amount whether we produce nil or to capacity.

Non-variable Expense.

Most of the remaining items are affected in some degree by volume. For instance, whatever the volume between these two points we shall only require the attentions of one manager. Some of us may consider that he isn't necessary anyway, but that's rather beside the point. Likewise the foremen and certain key workmen such as inspectors would not ordinarily be dismissed or stood off in times of depression, although the junior men would. The skeleton staff which is sufficient for normal volume would probably all be retained at zero volume either because of their knowledge of local conditions, consideration for long service, the difficulty of replacing them, or perhaps a matter of company policy. All such factors would have to be considered when computing the expense at zero volume. Although labour turnover is a factor which is always kept as near

as possible to the minimum, the great rank and file of hourly employees are not generally considered as indispensable and would not therefore figure as part of the idle plant burden. Each is considered, however, under his respective account whether he is a setter or a maintenance man, and a decision is made in each case. Certain material accounts will have to be computed for this purpose as a percentage of normal, but such arbitrary assessments call for the exercise of considerable care and experience. And so, if we consider each account in this way and ask of each one "How much of this expense shall we incur in the event of say a month's shut down?" we shall find that at zero volume we retain so many foremen, inspectors, clerks, etc., that we shall consume so much light, and in this way establish our total expense at zero volume. Since this expense will be incurred anyway it will not be influenced by production volume, and is called "non-variable." This is expressed as a percentage of productive labour at capacity. We are not attempting to say what is the expense at say forty or sixty per cent. volume, simply the expense at nil volume, the resultant curve that we can draw between the points set "nil" volume and capacity will for all practical purposes give us the true expense at any volume between these two points. This line could in fact be projected with reasonable safety to almost any point beyond capacity, since there are several items included in the non-variable expense which would not require to be augmented until well past capacity point.

The difference between the sum total of fixed and non-variable expense and the total expense at any point of volume along this line is the variable expense or that expense which is considered to vary hundred per cent. with production.

Now, having established these standards, the question is how to use them—the third part of our problem.

The controlling factor of our productive operations comes from sales volume. The sales department say what they expect to sell within a given period. This is not quite the case with jobbing engineers, but we are concerning ourselves here with principles of mass production. The sales department then having stated what quantity of product they require, and the buyer having said that he can supply the material required, the programme or production schedule is evolved. From this schedule the production man will calculate the number of productive hours and labour force required to meet this programme, and it would be well to emphasise at this point that the productive labour element is the yard stick for measuring the efficiency of manufacturing expense.

The expense at this volume will be (*a*) fixed and non-variable expense plus (*b*) the percentage of variable expense applied to this volume. If this is done for each account the production man will

know just how much can he spend on each account, and it is remarkable what efforts are made in actual practice to keep within these limits.

This expense can be broken down departmentally and can, of course, be applied equally to the actual productive labour when established as to a forecast. The departmental breakdown has the effect of putting each executive very much on his metal since his direct responsibility becomes a live thing—the results of his work receive the constant scrutiny of the board, and if as an incidental he is, and possibly his men also, are given some incentive award on the results achieved the closest possible control of expense is obtained, since there is no scheme to compare with personal interest, and an incentive plan certainly gives everybody a direct interest in every penny of expense which his department incurs.

Every penny of expense incurred is the responsibility of some member of the company, and comparisons of actual expense with standards are of the greatest possible value in keeping expense always in front of us. This is what is meant by real control.

By this means the dual purpose of factory cost and control of inventory is served—this expense, which often forms the bulk of factory cost, is kept at an efficient minimum, and the labour and burden in process, which are priced from these factory costs, and which frequently forms a very large part of the total inventory, if watched in conjunction with a well thought out planning or progress scheme, will also be kept moving and at a minimum.

Summary.

To sumarise the points made, we have seen :

1.—That the first essential to any well-balanced scheme is the harmonious relationship between all departments—a nice appreciation of the other fellow's job, in other words, co-operation. In this connection, it is sometimes good to reflect that, although we are all of us in business for the good and sufficient purpose of gathering as much moss as possible, we want, at the same time, to get some fun from the process of gathering..

2.—That knowledge as conveyed by figures must be circulated, understood and used.

3.—That factory costs based on a system of standards provide a constant unit cost by taking the unabsorbed or over-absorbed portion as a charge or credit against profits after applying the standard factory cost.

4.—That the factory cost after eliminating this excess or deficit is readily broken down into its three components.

5.—How the unit of absorption is determined, how the standards are established and finally, how control is exercised through the medium of these standards.

As a finale we will finish up with a short flight into the realms of higher finance by asking the question that some of us may be faced with in the near future, i.e., what additional volume would be necessary to enable us to reduce selling price per unit and, at the same time, maintain or increase the return on investment? A square chart drawn from the foregoing standards taking the fixed and non-variable expense as a bar, and the material and labour cost as fixed wedges topped by the variable expense drawn between the two points of zero volume and capacity would practically answer this question out of hand.

Discussion.

MR. J. SHAW: In opening this discussion I think I ought to congratulate Mr. Rose on a paper covering, as he says, what must be to many of us, a rather abstruse subject. Mr Rose has dealt with his subject in a very concise, and considering the comparatively short space of time available, in a very complete manner; in fact, he has made his points so clear, at first sight anyway, that it would appear that very little argument is possible. One or two points, however, might be usefully discussed in a little finer detail.

Mr. Rose says that production engineers are among the worst people possible for working in conjunction and co-operation with other departments, chiefly the commercial or accounts department There are probably many here to dispute that, so I do not propose to go into further details in this connection. The point is that the engineers, in their earlier training, perhaps do not get the opportunity to go into the accounting side of the business, due to their environment, supervision, etc., in fact, one almost might put it "They must not nose into other departments."

Mr. Rose sets out in a different manner, reasons why the engineer should be "pals" with the accountant. Perhaps in that respect I might say that I have found them to be of considerable help in estimating. One can pick up any amount of tips by going the right way about it. The author also refers to standards, meaning chiefly, I take it, piecework prices, but I think he also referred to standards set against fluctuating costs, that is to say, overhead, but as far as I can see, you can only set standards relating to these items after considerable experience, in other words, after a job has run for a considerable time. Perhaps Mr. Rose would make a few further remarks on that point.

In reference to scrap, Mr. Rose's plan is to place scrap against burden or overheads. This, I think, is open to some dispute, although I stand to be corrected. Taking the cylinder block, suppose we put hundred into the shop and finish up with eighty, it seems to me that the cost of the twenty which have been scrapped is going to cause some trouble with the overheads,

inasmuch as the number scrapped usually varies considerably from batch to batch, and it seems to me that by taking the quantity of material first issued, and multiplying that by the cost per piece divided by the pieces remaining at the end of the operations, that would give, perhaps, a more understandable idea of the cost per piece of the finished article. The overhead would then, of course, be added, being the usual percentage of labour, and it would naturally include the amount of labour expended in the scrap pieces.

In the case of direct labour, Mr. Rose says that direct labour is generally agreed to be that controlled practically by piecework. It is a point worth discussion as to just how far piecework can go. It is possible, where a factory is on continuous production, to put on prices per unit produced, for several other types of odd labour, for instance, floor sweepers and storekeepers may be paid on the price per unit. The point is just how far you can go with them. It is these things which want a lot of watching. If we go on to half production, the sweeping of floors may go on for a considerable time after production has stopped, consequently, overheads increase rapidly.

Dealing with the question of overheads, I believe Mr. Rose mentioned that various shops naturally demand a different overhead ; that is quite so. At a shop making, say, only one article, it would be interesting to hear opinions as to whether it pays to go into overheads so finely as to warrant the maintaining of a staff to deal with every different class of machine. The point I should like to emphasise here, is that in costing or estimating your own production costs against bought out prices, you must be very careful to split up your overheads because, as has been pointed out, you may get a machine which requires a very low rate of labour but a very high depreciation, which may run to 500 per cent. or 600 per cent ; of course, on assembly your percentage drops to practically nothing. One could go into details of many other points, but I think perhaps I have raised sufficient points to " start the ball rolling." Watch the accounts department and make " pals " with them if at all possible. My experience is that it pays every time.

Mr. Rose : You commenced by remarking that engineers were rather bad mixers. I have no previous acquaintance with the members of the Coventry Section, but so far as my own experience goes, I must say that I have had the utmost help from everybody on the production side, but it has not been easy work. Another point was as to how far we could take direct labour. I said that direct labour, generally speaking, was anything that could be measured against a pre-determined standard, but you cited the case of sweeping. The obvious answer is that we do not sell the operation of sweeping, and we could very well go on for quite a

while wallowing in our own mire, and do without the sweeping operation. That is not an essential operation, so I think that answers the question. As regards whether it is advisable to go into great detail in collecting our overhead expense, it is just a question of the overhead expense. If you care to carry out tests, in many of the items which you are averaging or lumping together, you would probably get some indication as to whether it was worth your while to expend a little more money to know exactly what that expense comprises, and so decide for yourself whether it is advisable to keep these accounts in great detail.

You also mentioned burden; that, again, is a question of fact. I said in the first place that the whole scheme of standards is sufficiently elastic to meet the actual facts. If you make one cylinder block as opposed to another block, the percentage of scrap is round about a given figure. If you want to come to job costs you have to record it definitely. It is just a question of the actual conditions of the shop, and that would decide whether you would take the overall burden percentage, or whether you would break it down finely into groups. Regarding scrap, and whether one should treat it as a job cost, and if twenty blocks were scrapped out of one hundred they should be charged to that particular job, I think my previous remarks answer that. If you are machining blocks almost week in week out, I would say your average percentage from that particular line would be sufficient on which to base the burden percentage.

MR. ELSON: I listened with great pleasure and interest, and I should like to support Mr. Shaw in offering thanks. I am not a production engineer, but one point mentioned which caught my attention was the question of tools. You mentioned tools as under the heading of expense. Do you mean depreciation or cost?

MR. ROSE: The answer is largely a question of policy; tools are brought into the balance sheet each year. When I said tools would be charged to expense, I had in mind depreciation, repairs and renewals. Each would be charged to the expense.

MR. P. A. SHAW: One finds that the greater the works knowledge the more carefully the works accountant is working with one, and the more constructive is his criticism. I agree that there must be co-operation, because I cannot possibly imagine anyone in an organisation more helpful than a works accountant when it comes to estimating. It depends on one's position in the executive organisation because the works accountant can then be either a good servant or a bad master, for instance, a good works cost accountant would slip on your table, say, weekly "your overtime has exceeded the budget," "your scrap is going up," etc., whilst the other fellow would wait until the end of the month and go up to the general manager. When a cost accountant does appreciate the works point of view, then he gets a proper line of the job.

How long would it take a cost accountant to tell the production engineer whether he is actually working to budget. Is it days or weeks? A further point is this. Having arrived at the fixed labour, how would you adjust your percentage burden in the event of a reduction in the piece rates, due to the introduction of more efficient methods and machining. Can you put me on to a good scheme for fixing inspection percentage to production costs?

MR. ROSE: How long would a really competent accountant require to give the figures to the production engineer? I should expect a complete balance sheet to be produced in seven days after the end of the month, that is the complete story of the actual cost incurred. How would the percentage burden be affected in the event of a reduction in the piece rates, due to the introduction of more efficient methods and machining? Alterations to time studies are going on continually throughout the whole year. I think this works out as to how much can a viewer, examiner or inspector do on that particular bench in the course of a given eight hours. It is not customary to put them on to piecework, except in such cases as an engine inspector. You know how much you spend in the way of inspection. By your capacity volume you can also say how much is non-variable, but the remainder is variable.

A VISITOR: In dealing with direct labour, is there a danger of covering up inefficient rate fixing?

MR. ROSE: By throwing the inefficiencies out to one account, it absolutely shrieks for itself. Either your production man is not able to get the best out of his operators, or the time is a harsh one and must be altered. I assume, in the first instance, that your rates and standards are capable of being demonstrated.

MR. E. W. HANCOCK (President, Coventry Section, who presided): Mr. Rose is to be congratulated not only on his actual paper, but on the thoroughness and practical way in which he has explained the more difficult points. Works cost accounting is often regarded as a very dry and uninteresting subject, but the way in which it has been presented to us to-night, I am sure, has created the greatest interest amongst us all. Up to a certain point, I am inclined to agree with Mr. Rose, not so much in his criticism of the production engineer, but in the importance of production engineers always having before them the question of costs. A very eminent engineer of my acquaintance, makes a very definite statement regarding business, namely, "we are only in business to make money." There is no doubt in anyone's mind to-day, that sound financial control leads to progress and development, and whatever humanitarian ideals we may foster, none of these ideals can be reached unless the businesses with which we are connected, are financially sound. To my mind, the days of optimism and good luck are past, and to-day businesses are usually successful be-

cause the success is based upon sound prediction and the knowledge of what is going to happen in sufficient time to modify the outlook.

Mr. Rose states that he can furnish figures within seven days of the end of the month, showing exactly how the business is running in relation to the budget, etc., but to my mind, this information is four weeks too late, and that information regarding the trend of events should be available at the end of the first week in the month, and issued weekly. We should give much more importance to this question of trends, as the object is always to achieve the prediction, and not to look for excuses after the objective is lost, such as is usual when "results" are published, as it is then too late. Also, even though it may be argued that the loss of one month can be made up in the following month, the information supplied on the previous month may still not convey the correct influence as volume of product may be varied from month to month, and unless figures appertaining to budgetary control based on volume are issued indicating trends as early in the particular month as possible, we are, to my mind, only logging history, and not obtaining the guiding hand from the works accountants, which is so necessary if we are to reach a forecasted objective.

As production engineers, and taking a somewhat practical view, I would regard works accounts somewhat in the light that we, when in the shops, regarded the shop viewer, that is to say, we must rely on the works accounts department to tell us whether we are right or wrong, and if they, as good shop viewing should be conducted, tell us the result of the first piece of the batch, we know that if we produce the remainder of the batch to the same standard as the first one checked, that we are likely to have the whole batch passed. This, as against the system of viewing whereby a whole batch is machined before any inspection is made, with the possibility of the whole batch being scrapped, is an illustration of the difference between waiting until the end of the month, or having an early check.

We should always train ourselves to accept the figures as supplied by the works accountant's department, as, whatever we think, his figures are the ones accepted by the board, and what they say usually goes. This leads us to the point raised by Mr. Rose, namely, the question of co-operation between the works accountant's department and production engineers. I am not very much in favour of the word "co-operation," as it is very difficult to define, and I would rather use the word "understanding." If the works accountant's department and the production engineers have a better understading of each others function, there is no question that results will bear out the forecast figures, and I heartily endorse Mr. Rose's views that the works accountants are, or should be, the production engineers' best friends.

The two types of control now almost universally in use, are (*a*) Whereby a product must be produced in certain volume at a definite price ; (*b*) Where an estimate is made, from which selling prices are fixed. The old system of "time and line," whereby work was carried out first, costs made out, and profit added, is no longer with us.

In the two systems referred to, therefore, sound forecasting is definitely the result of the works accountant's department and the production engineers working together, having a full and complete understanding of the objective in question, and there is no doubt that if the first and underlining figures are worked out by these two departments with complete understanding, that this sets down a sound foundation for good business. In conclusion, I would again stress the importance of the works accountant's department standardizing on a scheme whereby they automatically notify the production engineers of the way in which they are running in sufficient time to give the production engineers an opportunity of reaching the objective.

MR. ROSE : The cost man is one who essentially deals from first to last with figures and facts, and he has just as hard a job to get them accepted by the board as does the production engineer. The system mentioned to-night is very elastic and meets everything asked for by Mr. Hancock.

MR. TIPPING : In the past, much to my annoyance, I have been up against the works accountant who wanted to make a rough guess at different times. Any accurate system of costs must ultimately be based on a kind of machine rate, that is to say, you must take into account the cost of the machine, the depreciation, and the amount of floor space occupied. No rough and ready methods will do. In regard to work in progress, if we have twice as much work in progress, this is like having to earn dividends on a larger capital. I do hope that in future we shall find more works accountants coming nearer to the technical side.

MR. ROSE : I should like to say that a system of standards is intended to reflect true facts. I visualised the simplest scheme of straight repetition work where a method of labour was the simpler one. I know that the machine hour basis is sometimes preferable. You may rest assured that what I have advocated to-night is intended to reflect true costs based on actual conditions. As regards material in progress, following on what I said of having each of your productive operations definitely rated, it means that if you have worked up your labour in accordance with your schedule, then obviously your material must move to keep each man employed, and then by doing that you will keep down your investment in both labour in process, burden in process, and that to my mind is one of the first requirements of the production engineer.

MR. AIERS: The main point is to prove that budget control is the best thing. We agree that full capacity is the most desirable state for a factory to work on. I also agree that when we are not working at all, that will give approximately a high line. Will this make any difference when you are slowing down production, which is usually because you are changing on to a new model? With a new model I should say the curve would not keep straight. You mentioned that the end of the curve could carry on that line by moving over capacity. I cannot see this, because if you are working on capacity you can only increase it by putting on a night shift or working overtime. If this is done you have extra lighting, heating, and a lot more overheads, and I should have thought that would have made a difference to the curve.

MR. ROSE: Would the curve be a true reflection in the case of the change of model? A change of model in the ordinary way is expected in most concerns to occur in August. We know that the expenses can be anticipated, and most of them are capitalised, such as the drawing and manufacture of numerous jigs, tools, etc., and most are capitalised and kept out of the expense. For the remainder it is just a matter of basing on past experience and spreading it over into your average. You know what you are going to incur in the course of any one year. Put that into your job. If we extended the line beyond capacity, the curve would not be quite true. I said one can do it with reasonable safety since it is an approximation. You would not find it a very long way out, and you could anticipate the abnormal expense in the way of overtime, premium and additional lighting, and get near the truth in that way I mentioned the chart purely as a trend rather than as a fact.